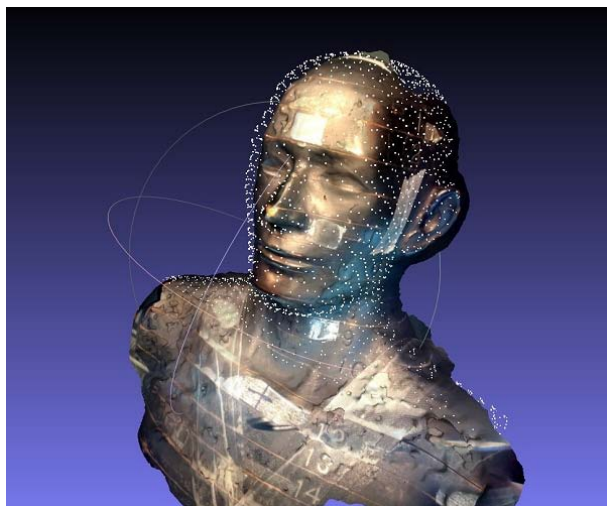


we are now ourselves developing an In-house software to do this. The RANDO Man Phantom (The Phantom Laboratories, Salem, New York) was used as a model. RANDO represents a 175cm tall and 73.5kg male figure. The phantom is constructed with a natural human skeleton which is cast inside soft tissue-simulating material. An image fusion was carried out between a RANDO OSS and a RANDO CT scan. A Body structure was created in our CT scan. In order to fusion it with the 3D-OSS we used MeshLab (a free processing system for 3D triangular meshes).

Results: Image fusion was successfully performed and the accuracy of it was measured both using predefined corresponding landmarks in the CT and visual confirmation. We performed this process for two locations on the phantom, Head & Neck and Body, and in both cases we got an accurate agreement.



Conclusion: This study was carried out using an existing commercial app in order to prove the feasibility of the method, using only a smartphone and free software. Therefore, we think it reasonable to believe that making your own 3D-OSS system could be done both in a simple and in a much cheaper way than the usually commercial alternatives available on the market.

EP-1779

Margins to compensate for deformity of the prostate/seminal vesicle in IGRT using fiducial-markers
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Purpose or Objective: In external beam radiotherapy for prostate cancer, image-guidance using fiducial-markers decrease set-up error and inter-fractional organ-motion error. However, daily deformity and/or rotation of the prostate/seminal vesicle could not be adequately detected by the verification of fiducial-marker position alone. The purpose of this study was to know how many margins should be added to compensate for the daily deformity and/or rotation of the prostate/seminal vesicle in the image-guided radiotherapy using fiducial-markers.

Material and Methods: Three-hundred ten fractions of nine patients with prostate cancer were examined. Patient setup was performed according to the position of two intra-prostate fiducial-markers (first-stage). Thereafter, with considering deformity and/or rotation of the prostate/seminal vesicle, the patient position was moved to the best position to achieve an alignment of contours of the prostate/seminal vesicle on daily cone-beam CT and contours of the clinical target volumes delineated on treatment planning CT (second-stage). Distance of movement in the second-stage was measured.

Results: An alignment in the second-stage was needed in 47 fractions of 310 fractions (15.2%). In 43 fractions (13.9%), movement of 1 mm was needed only in antero-posterior (AP) direction. Movement of 2 mm in AP direction, movement of 1 mm in cranio-caudal (CC) direction, and movement of 1 mm in AP and CC directions were needed in two fractions (0.6%), in one fraction (0.3%), and in one fraction (0.3%), respectively. No fraction needed an alignment in left-right direction.

Conclusion: With regard to image-guided external beam radiotherapy based on intra-prostate fiducial-marker position, margins of 1-2 mm in AP direction are necessary to compensate for the daily deformity and/or rotation of the prostate/seminal vesicle.

EP-1780

Dosimetric impact of isocenter accuracy in CBCT-guided SRS treatment of vestibular schwannomas

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Purpose or Objective: Linac radiation isocenter describes a path while gantry and couch are rotating during the treatment delivery of typical non-coplanar SRS plans. The aim of this study is to investigate the dosimetric impact of this isocenter "wobble" in SRS of a vestibular schwannoma (VS), and to validate the PTV margin used in our clinical practice.

Material and Methods: Five VS cases were enrolled in this study. The PTV was generated in the Eclipse TPS by expanding the CTV by an isotropic 2 mm margin, according to our SRS policy. A SRS non-coplanar plan ("reference plan") was designed in the Eclipse TPS by using static gantry IMRT technique. Eleven beams (6 MV) from a Varian Clinac equipped with a 120 Millennium MLC were used. Dose of 12.5 Gy (100%) was prescribed to cover 99 % of PTV.

On the other hand, fifteen CBCT-guided end-to-end (E2E) tests using a skull phantom were performed. E2E test permits to quantify the radiation isocenter misalignments in the X (lateral), Y (anterior-posterior) and Z (superior-inferior) directions.

For each VS case, eight X-Y-Z shifts generated from "mean \pm 1.96 x SD" misalignments reported by E2E tests were simulated in the Eclipse TPS, resulting in eight "shifted plans". The following metrics were computed for each shifted plan and compared to the reference plan values: i) dose coverage of the CTV (D99%_CTV), ii) maximum dose to brainstem, iii) mean doses to cochlea, and iv) V10Gy, V5Gy and V2.5Gy of the brain (including the PTV).

Results: 1) Isocenter misalignments revealed by E2E tests were (mean \pm SD): -0.4 ± 0.7 mm, -0.2 ± 0.5 mm and 0.2 ± 0.4 mm, in the X, Y and Z directions, respectively. Gaussian behavior was observed for each direction ($p > 0.05$; Shapiro-Wilk test). The probability of having shifts ≥ 2 mm is less than 1% in Lat, AP, and SI directions.

2) Target coverage was assured in the shifted plans; D99%_CTV: $103.1\% \pm 5.8\%$.

3) Shifted plans vs. reference ones revealed not statistically differences ($p > 0.05$; Two-tailed Student t-test) in brainstem maximum dose (7.1 ± 3.0 Gy vs. 7.2 ± 3.1 Gy); cochlear mean dose (5.3 ± 4.1 Gy vs. 5.1 ± 4.4 Gy); V10Gy brain (2.3 ± 1.5 cm³ vs. 2.3 ± 1.6 cm³); V5Gy brain (8.6 ± 5.1 cm³ vs. 8.6 ± 5.8 cm³); and V2.5Gy brain (43.4 ± 26.7 cm³ vs. 43.5 ± 30.1 cm³).

Conclusion:

1) The radiation isocenter "wobble" did not increase significantly the doses to brainstem, cochlea and brain.

2) Our study demonstrated that the 2 mm PTV margin used in our clinical practice was adequate for SRS treatment of VS.

EP-1781

Dosimetric impact of CBCT isocenter misalignment on target dose coverage in cranial SRS

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Purpose or Objective: Perfect (zero error) coincidence of CBCT and linac's isocenters is practically impossible to achieve in clinical practice, due to the presence of several geometric errors in the treatment unit. Our aim is to analyze the dosimetric impact of CBCT isocenter-linac isocenter misalignment on the target dose coverage and tumor control probability (TCP) in cranial SRS plans.

Material and Methods: A Varian Clinac 2100 CD was used. Misalignment of CBCT isocenter with respect to (w.r.t.) radiation linac isocenter was measured during 23 consecutive months. A 5 mm tungsten ball was centered at the room laser isocenter and MV portal images were acquired for four cardinal gantry angles (couch was at zero position). After portal image acquisition, CBCT scan was acquired.

All images were analyzed: (a) deviation of the radiation isocenter w.r.t the ball center was measured in each MV image using an in-house code; (b) deviation of the central voxel of the CBCT matrix ("CBCT isocenter") w.r.t. the ball center was measured in the Eclipse TPS. Finally, 3D misalignment of the CBCT isocenter w.r.t the linac isocenter was derived from (a) and (b).

To analyze the dosimetric impact of the CBCT isocenter misalignment, 10 cranial SRS cases were randomly selected from our database. For each case, the isocenter in the original plan ("reference plan") was shifted according to the misalignments obtained for CBCT isocenter. Eight X-Y-Z shifts generated from "mean \pm 1.96 x SD" of the measured CBCT isocenter misalignments were simulated for each SRS plan (i.e., 8 "shifted plans" were obtained for each SRS case). Target dose coverage (D99%) and TCP (estimated according to Radiat Oncol. 2015 Mar 8;10:63) were computed for each shifted plan and results were compared to the reference plan ones.

Results: i) Misalignments of CBCT isocenter w.r.t. radiation linac isocenter were (mean \pm SD, all in mm): 0.5 ± 0.3 ; -0.3 ± 0.2 and -0.6 ± 0.3 for X (lateral), Y (anterior-posterior) and Z (inferior-superior) directions, respectively.

ii) Target dose coverage (D99%) was degraded from 100% to a mean value of 93% (range: 80% to 100%).

iii) The average loss of TCP was estimated to be about -5% (range: -18% to 0%) among the 80 shifted plans generated in this study.

Conclusion: Our simulations demonstrated that the reduction of target coverage and TCP due to CBCT isocenter misalignment w.r.t linac isocenter may be important. Our study shows clearly the need of add margin to the target to compensate for CBCT isocenter misalignment.

EP-1782

Effect of daily variation in rectal and bladder filling: an analysis of planned versus actual dose

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Purpose or Objective: In the era of Image guided radiotherapy (IGRT), ensuring accurate delivery of planned high dose is very important. Daily variations in organ volume may result in difference between planned and actual dose delivered to an organ. In the present study we planned to analyze the daily variations in bladder and rectal filling and its effect on actual dose delivered when compared with original planned dose.

Material and Methods: Five consecutive cases of carcinoma prostate, who recently concluded their IGRT, were selected

for the study. All cases were high risk prostate cancer, planned for radical IGRT for a dose of 50 Gy in 25 fractions to prostate and pelvic nodes, followed by Cyberknife boost for 3 fractions. Daily cone beam CT - XVI (X-ray volume imaging) acquired during daily treatments for each patient was exported to planning systems and after fusion with original planning CT, daily bladder and rectal contours were delineated on each 125 scans (B1-B25 and R1 - R25). Using superimposition of all new 250 contours on respective original plan, dose delivered daily to partial volumes of these organs was recorded using new actual DVH (dose volume histogram) and then statistically compared with their respective original bladder and rectal (B0 and R0) DVH using SPSS v18.

Results: Even with strict bladder and rectal protocols, daily volumes varied in all individual cases. The range of bladder volume variation (B1-B25) recorded for 5 cases were: 30.7%-211.1%, 26.9%-119.1%, 27.8%-107.2%, 15.4%-305.8% and 27% - 92.6% of B0, respectively. Overall actual mean volumes were within 25% variation range (mean actual 76% of B0). For rectum, R1-R25 volumes varied from 30.9%-205.9%, 47.5%-155.1%, 33.8%-150.2%, 44.6%- 208.1% and 43.4%- 140.2% of R0, respectively. Overall mean actual rectal volume were very similar to original rectal volume (101.6% of R0). Overall actual bladder dose (D1-D25) was lesser than original bladder (D0) dose. Statistically significant lower actual mean dose (range 13 to 30%) was observed when recorded for 25cc to 85 cc of bladder volume ($p < 0.05$). For lower volumes less than 20 cc, difference was not significant. For rectum, difference between delivered and planned dose was statistically non significant for any volume. A comparison of volume to dose data showed a difference in planned and mean actual V15, V20 and V25 for bladder and V5 to V30 for rectum, which was statistically significant ($p < 0.05$).

Conclusion: Strict bladder and rectal protocols both for simulation and delivery is important in planning pelvic radiotherapy due to physiological variations in their daily volumes. Exact duplication of bladder and rectal volumes is difficult, however by using image guidance and ensuring at least 25% concordance of daily with original planning volumes of these organs, possible differences in actual delivered dose can be mitigated and accurate delivery of planned dose can be ensured.

EP-1783

Translational and rotational set-up uncertainties in Head and Neck cancer treatments using CBCT

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Purpose or Objective: The aim of this study was to assess setup errors, both translational and rotational, for head and neck (H&N) cancer patients treated with intensity-modulated radiotherapy (IMRT) and volumetric-modulated arc therapy (VMAT) using daily pretreatment CBCT imaging guidance.

Material and Methods: A total of 57 CBCTs referred to 7 patients treated with an Elekta Agility Linear Accelerator were analyzed. Patients were treated in a supine position; as immobilization system for head and shoulder a thermoplastic fixation mask was used. Tattoos on the surface mask were placed on the laser projection. Axial CT-planning slices at 5 mm intervals were acquired and reconstructed at 2 mm. Image data set were sent to the Oncentra Masterplan Planning System. Planning CT was also sent via DICOM to XVI software for the co-registration with the CBCT scan. For the CBCT acquisition we used the "fast head and neck S20". The 3D-3D co-registration with the CT planning scan was performed using the Grey level algorithm. Translations were measured in medio-lateral (x), supero-inferior (y) and antero-posterior (z) directions, as well as in rotation around axes. Online correction for translational displacements were applied, on the basis of literature data, when the discrepancy exceeded 3 mm. Rotation corrections were recorded with a